REPORT OF OFF-SITE SURVEILLANCE FOR PROJECT GASBUGGY
March 1967 to June 1968

by
Environmental Surveillance
Southwestern Radiological Health Laboratory

Department of Health, Education, and Welfare
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ABSTRACT

The Southwestern Radiological Health Laboratory (SWRHL) began off-site radiological safety operations for Project Gasbuggy in June, 1967. A census was taken during the following three months of all people and milk cows within 100 miles of the Gasbuggy site. All mining and tunneling operations within 50 miles were also located. As the census information was collected, SWRHL personnel distributed printed information, explained the nature of the experiment, and answered questions regarding their activities. The Community Relations Program was intensified during later periods when the SWRHL Project Officer and state health officials visited local officials in surrounding communities.

The collection of environmental samples to establish background levels of radioactivity was started in early August, 1967, when milk and water samples were collected. Vegetation samples for background information were collected in early December, 1967. A 35-station air surveillance network began operating on November 21, 1967. All 35 stations operated through December 13 when the number was reduced to twelve; these operated through the drill-back period. Milk and water samples were collected following the shot and the drill-back operations to find if radiation levels had increased.

The dosimetry program was started in October, 1967. A network of thermoluminescent dosimeters was established around the site at an approximate eight-mile radius. The dosimeters were

exchanged once during the background period, again a few days prior to the event, and collected following the drill-back operations.

The Medical and Veterinary Officer's activities began in mid-October, 1967, and continued through the drill-back period. These activities consisted of visiting federal, state, and local officials and remaining on standby to handle emergencies that might arise during the operational period.

The operational period, or period of major monitoring activity, began in early December, 1967, and lasted until mid-January, 1968. Approximately 30 people from the SWRHL and the health departments of New Mexico and Colorado were assigned to the project. At detonation time, the SWRHL had 33 personnel on location, including monitoring teams in two aircraft orbiting the site. During the drill-back period, the SWRHL provided five monitors for surveillance.

No release of radioactivity was detected by monitoring or in the analysis of samples collected following detonation. This report presents the activities, data, and conclusions of surveillance activities during the period March 1, 1967 to June 1, 1968.

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I. INTRODUCTION

The Project Gasbuggy nuclear explosive of 26 kilotons design yield was detonated on Sunday, December 10, 1967, at 1230:00 Mountain Standard Time.

The explosive was emplaced at 4240 feet below ground surface, 1770 feet from the west line and 1218 feet from the south line in Section 36 of Township 29 North, Range 4 West, in Rio Arriba County, New Mexico about 55 air miles east of the city of Farmington, New Mexico. The geodetic coordinates are: Latitude-36°40'40.4" North; and Longitude-107°12'30.3" West. The elevation of surface ground zero was 7204 feet above Mean Sea Level.

The detonation occurred in the Lewis Shale formation of the San Juan Basin about 40 feet below its contact with the gasbearing Pictured Cliffs sandstone formation.

Early indications are that the explosive performed satisfactorily.

The Off-Site Radiological Safety Program for Project Gasbuggy was conducted by the Southwestern Radiological Health Laboratory (SWRHL) of the Public Health Service (PHS). SWRHL was responsible to the Atomic Energy Commission(AEC) Project Manager for providing the services outlined in Chapter 0524-05, SOP-NTSO, and particularly for:

1. Maintaining a comprehensive record of background environmental radioactivity in the off-site area during the Project Gasbuggy operational period.

2. Documenting the type and extent of any off-site environmental radiological contaimination resulting from the Project Gasbuggy experiment.

3. Assuring continuous protection of public health and safety during the operational period by determining potential exposures and performing suitable protective measures when directed by the Project Manager.

4. Conducting a continuous program of personal contacts in the surrounding communities to develop and maintain local confidence that public safety was being guarded throughout the project period.

5. Reporting off-site area incidents or complaints attributed to project operations to the Project Manager and assisting in the investigation of such matters as directed.

SWRHL also represented the PHS in its responsibility for surveillance of radioactive materials in the environment.

Radiological Safety Criteria

The off-site radiological safety criteria for the project were those established by AEC Standards for Radiation Protection, Appendix

to Chapter 0524, Section II-A. The criteria recommend the whole body dose should not exceed 0.5 rem for any one individual nor more than 0.17 rem for any suitable population sample in any calendar year. The dose is exclusive of exposure to natural background radiation, medical X-rays, or other types of radiation therapy. The criteria also recommend the dose to the thyroid should not exceed 1.5 rads to any one individual or 0.5 rad thyroid dose to the general population.

II. PERSONNEL AND ORGANIZATION

Personnel responsible for the off-site radiological safety program were assigned from SWRHL. Field operations were directed by the SWRHL Project Officer; overall supervision of SWRHL activities was assumed by the Acting Director of SWRHL.

Four employees were assigned to New Mexico and Colorado to take the pre-shot census of people, milk cows, and mines, and were in the area from mid-June until early September, 1967.

A contract between the PHS and the State of New Mexico provided laboratory and office space, and a radiochemist and laboratory technician from June 1, 1967 to January 31, 1968. Radiological counting facilities were established in the Farmington laboratory.

The SWRHL staff was augmented by ten health officials from New Mexico and four from Colorado. In addition, the PHS Region VII office in Dallas supplied one radiological health representative.

The Medical and Veterinary programs were the responsibility of the SWRHL Medical and Veterinary Officers assigned to the project.

The New Mexico and Colorado public health personnel who had only minor experience in radiological health attended a one-week course (August 21-25, 1967) on "Fundamentals of Radiological Health" at Albuquerque, New Mexico. The course was taught by personnel of the SWRHL Technical Training and Reports Program.

All field personnel attended a two-day training course in monitoring procedures and project orientation. Following this, they spent six days in the field learning the location of all off-site residents within 30 miles of ground zero. Each day a briefing and operations lecture was held for all field personnel.

Field personnel were assigned as either monitors or zone supervisors. The function of a monitor was to document levels of radiation off-site, collect environmental samples off-site, and assist the zone supervisor. The function of a zone supervisor was to take on-the-spot responsibility for any emergency action procedures, as explained later in this report.

A total of 33 personnel assigned to the PHS were in the area on the day of the event (December 10, 1967). Twenty-two personnel were in the field (15 monitors, 4 zone supervisors, the Medical and Veterinary Officers, and a Jicarrilla Apache interpreter was with one of the monitors). Six aerial monitors (two teams) were in two aircraft orbiting the site. Two laboratory technicians were on standby in Farmington and three people were at the Control Point (the SWRHL Acting Director, the Project Officer, and the Radio Controller).

The Acting Director of SWRHL was on location for the event as a member of the AEC Project Manager's Advisory Panel and assumed local direction of all SWRHL surveillance activities.

Five monitors, including the Project Officer and the field laboratory radiochemist, provided monitoring surveillance during the re-drill period (December 15, 1967 to January 18, 1968).

III. PRE-SHOT CENSUS

Population census, Grade A dairy locations, and family milk cow locations were determined within 100 miles of ground zero. In the area within 50 miles, all individual ranches and dairies were contacted by a SWRHL representative. The individual citizens of a town within 50 miles were not contacted; instead, the population for the entire town was estimated and all milk cow owners located. In the area between 50 and 100 miles, the population was summed into small geographic areas (for example - an unincorporated area containing numerous farms and ranches). The population was estimated for each of these areas and the family milk cows and Grade A dairies were located. In most cases only a few of the citizens within these areas were contacted.

The prevailing winds of the Gasbuggy area for most of the year move in the direction between 45° and 135°. For this reason, the population and cow census was extended in this sector to approximately 125 miles and in some cases to 140 miles.

The population and milk cow information was recorded on a Sampling and Census Form as shown on Table 1 of Appendix A. The information was later computer tabulated and presented by counties in the Gasbuggy Census Directory.

Mine location surveys were conducted to a distance of 50 miles from ground zero. Six mining or tunneling operations were found; however, all were more than twenty-five miles from ground zero

and, therefore, the AEC Project Manager did not direct the SWRHL to provide any specific surveillance for these underground operations.

IV. COMMUNITY RELATIONS

The community relations program began with the pre-shot census. The Project Officer preceded the census takers into each area, visiting state and local officials to explain SWRHL activities, to distribute information on the nature of the Gasbuggy experiment and to solicit aid in collecting census information. As the census takers collected information from individuals and local officials, they also handed out printed material and answered questions regarding the project.

Later in the fall, the Project Officer and a health official from New Mexico and Colorado visited communities in each respective state. They spoke with officials in each community within 100 miles of the Gasbuggy site, answered questions, and made themselves available to answer questions and speak to civic and social organizations.

Evening talks were given by the Project Officer and movies shown to the Bayfield Lions Club, Bayfield, Colorado, and the Bluffview Elementary School PTA, Farmington, New Mexico.

A press release was prepared by SWRHL at the request of the editor of the Farmington Daily Times. This story was about SWRHL activities in the area and was released through the AEC.

V. MEDICAL ACTIVITIES

The SWRHL Medical Advisor contacted local health and medical authorities in the area including the PHS Indian Health Service on the Jicarrilla Apache Reservation and the Navajo Reservation. Arrangements were made with the San Juan County Health Officer, the Espanola Hospital Administrator, the PHS Medical Officer at Dulce, the District Health Officer for Rio Arribo County, a private physician in Parkview, and the Farmington Hospital Administrator to use their facilities in the event of any emergencies.

The Medical Advisor spoke with various local health officials including those mentioned above, and local public health nurses regarding any persons living in a possible evacuation area who might have been under the direct medical care of a local physician. After a thorough investigation, the Medical Advisor found one possible case. He spoke with the person and determined the circumstances did not warrant a pre-shot evacuation.

The Medical Advisor was in the area from December 2 to 12, 1967, to make the above contacts and arrangements and to answer medical questions regarding SWRHL activities asked by local health officials or citizens. The Medical Advisor encountered no event-connected medical problems in the Gasbuggy area following the detonation.

VI. VETERINARY ACTIVITIES

The Veterinary Officer assigned to the project contacted state and federal livestock regulatory officials, local practitioners, county agents and other local agricultural leaders. He provided information about the project, answered questions, and asked them to report any problems which might arise.

Samples of three deer were collected for background biological information in an area approximately 20 miles from ground zero. These samples, collected in the field by the Veterinary Officer with the aid of a New Mexico State Fish and Game official, were returned to SWRHL for analysis. Since no venting occurred, no post-shot game samples were taken.

The Veterinary Officer was in the area from November 29 through December 12. He was in the field on detonation day and remained in the area several days following to investigate any livestock or wildlife damage claims arising from the Gasbuggy experiment; however, no claims were made.

VII. MONITORING

Aerial Monitoring

Aerial surveillance, including aerial monitoring and sampling, was performed by SWRHL for the Gasbuggy event. Two aircraft were orbiting ground zero at shot time; a U. S. Air Force C-47 with a crew of SWRHL monitors for cloud tracking and monitoring, and a SWRHL Turbo-Beech for low altitude monitoring, sampling, and tracking of any released radioactivity. A second Turbo-Beech was available in Las Vegas, Nevada for extended tracking and sampling.

After the detonation at 1230 MST, December 10, the Turbo-Beech made seven low altitude passes at 500 to 1,600 feet over ground zero from 1236 to 1308 MST; during this time all detection systems were operating. The primary detection system was a single channel analyzer-count rate-meter with a 4-inch by 4-inch sodium iodide crystal detector (operating range 2 to 5,000 μR/hr). Survey instruments identical to those carried by the ground monitors were the secondary detection systems. The aircraft was also equipped with five air sampling systems for collection of particulates, reactive gases, and inert gases; and for size-activity correlation of the particulate activity. One gas sample was collected over ground zero during the 1302 pass at an altitude of 500 feet. The C-47 circled ground zero on a two mile radius at 11,000 feet MSL until H+40 minutes. At H+40 minutes a pass was made at 500 feet above ground zero before returning to the

Farmington Airport. The Turbo-Beech was released at 1343 MST and returned to Farmington at 1400, where it remained on standby for the next 36 hours.

All readings made in both aircraft during the mission were at background levels. Analysis of the gas sample indicated no fission products.

Ground Monitoring

Ground monitoring was provided by 15 ground monitors, 4 zone supervisors, and the Medical and Veterinary Officers. All of these personnel were equipped with the following equipment:

a. Vehicle with a Net 4 radio.
b. Scintillation Survey Instrument, Baird Atomic Model NE-148, (range of 0.01 to 3 mR/hr).
c. Geiger Counter Survey Instrument, Eberline E-500B (range of 0 to 2000 mR/hr).
d. Ionization Chamber Survey Instrument, Victoreen Radector Model AGB-50B-SR (range of 0.05 mR/hr to 50 R/hr).

Each ground monitor was also equipped with milk, water, and vegetation sampling equipment, and ten monitors were each equipped with portable air samplers, and portable gamma exposure rate recorders. Details of the air samplers are given in the air sampling section of this report. The exposure rate recorders consisted of an E-500B instrument connected to a Rustrak strip-chart recorder. The recorder was battery-powered and the entire system was completely self-contained in a carrying case. The air samplers and recorders were designed to be set up and left running in the field while the monitor carried out monitoring

duties at other locations.

In addition to the ground monitoring capability described above, seven personnel with survey instruments were on standby on shot day at the airport in Las Vegas, Nevada. These people were ready, if necessary, to be flown in New Mexico by SWRHL aircraft and used in outlying areas. They were on standby from shot time (1230) until approximately 1500 MST.

Ground monitoring performed in the afternoon following the shot and all ground monitoring performed during the re-drill period showed no increase of radiation over background levels.

VIII. DOSIMETRY

Dosimeters and Film Badges

A network of thermoluminescent dosimeters (TLD's) and film badges was established surrounding the Gasbuggy site. The network consisted of 50 stations located at approximately 1-1/2 mile intervals, along existing roads and highways as shown in Figure 1, Appendix A.

The background radiation level for the network area was established prior to the shot with stations consisting of three dedosed TLD's set out on October 17, 1967, and exchanged on November 15, 1967, to determine background radiation levels. They were exchanged again on December 8, two days before the shot, and replaced by three dedosed TLD's and two film badges.

TLD's were worn by all PHS field personnel on shot day. In addition, 120 TLD's were with one field monitor to be used in case of venting to establish additional networks. These networks would have been along roads across the cloud effluent path to delineate the cloud passage pattern and to document exposure levels.

The TLD's used were EG&G Model TL-12 thermoluminescent CaF_2:Mn dosimeters, (sensitivity range of 1 mR to 5,000 R) and two Du Pont Type 545 film badges (sensitivity range of 30 mR to 3 R). Since there was no venting on detonation, the TLD's and film badges set out December 8 were left in the field through the drill-back period which began immediately after the shot. The drill-back

period was completed on January 15, 1968, and the TLD's and film badges were returned to Las Vegas for analysis.

Table 1 of Appendix B gives the summary of exposures recorded by each of the 50 TLD stations for each period of exposure. These values are the averages for each station.

The data from the post-shot period show that no exposures above background were recorded by the network which encircled the Gasbuggy site.

Human Surveillance

The whole-body counting facility at SWRHL was available to monitor SWRHL personnel exposed to radiation had venting occurred. The service was available on a 24-hour basis and the facility could have been used for other than SWRHL personnel if approved by the AEC Project Manager. A thyroid counting trailer was also on standby in Las Vegas, Nevada on the day of the event. Had venting occurred, and the AEC Project Manager so directed, the trailer would have been directed to any area affected to measure thyroid burdens.

IX. ENVIRONMENTAL SAMPLING

Air Sampling

The Gasbuggy Air Surveillance Network collected daily samples at 35 locations surrounding the Gasbuggy site. Six of these stations were part of the SWRHL Air Surveillance Network (ASN) and two were activated ASN standby stations. The remaining 27 stations were established specifically for this project. The Gasbuggy network stations are given in Table II of Appendix A and their locations shown in Figure 2 of Appendix A.

Air sampling stations were equipped with Gelman "Tempest" air samplers using a Gast Model 1550 positive displacement pump. The filter system used was a 4-inch diameter Whatman 541 filter followed by a 4-inch BM 2306 activated charcoal cartridge.

The Gasbuggy Network began operation on November 27, and continued through December 13, 1967. Nine of the stations nearest the site continued operation through the drill-back period to January 19, 1968. A total of 1120 sets of samples were collected. The method of analysis for the air samples is described later in this chapter.

The basic air sampling coverage described could have been supplemented by three additional networks had a release of radioactivity occurred. These networks are the:

a. Radiation Surveillance Network (RSN). Fifty-five permanent stations located nationwide operate routinely, collecting

daily samples. These stations use a 4-inch diameter cellulose BM 2133 dust filter. Samples are presently analyzed at the PHS Radiation Surveillance Center in Rockville, Maryland, and the data are available to SWRHL upon request.

b. Air Surveillance Network (ASN). One hundred and ten permanent stations located west of the Mississippi River operate continuously, collecting daily samples of air particulates. Twenty-six of the stations also operate daily with charcoal cartridges. All stations can be activated to use charcoal cartridges, if necessary. These stations are the AEC's off-site surveillance network for NTS operated by SWRHL, and use Gelman "Tempest" samplers with a 4-inch diameter Whatman 541 particulate filters followed by a 4-inch BM 2306 charcoal cartridge. Samples were mailed daily to SWRHL for radioassay. In addition to the permanent stations, ten standby ASN stations have been established in the inter-mountain region of the United States. Upon notification these stations start operation and use equipment identical to the permanent stations.

c. Utah Cooperative Network. Arrangements have been made with Dr. Grant Winn, Chief, Industrial Hygiene Section, Division of Environmental Health, Utah State Department of Health to obtain samples collected daily from six of their network stations. The samples are collected on BM 2133 carbon-impregnated filters, and upon request to Dr. Winn, the filters can be mailed daily to the SWRHL for analysis.

In addition to the above networks, ten monitors stationed in the off-site area were equipped with portable air samplers. This sampler was a Roots-Connersville Pump (Frame 1702 - Series 162) coupled to a 3 hp Tecumseh propane engine. The sampler pumps approximately 10 cfm through a 4-inch diameter Whatman 541 filter followed by a 4-inch BM 2306 activated charcoal cartridge. In the event of a release of radioactivity these samplers would have been set up by the monitors at locations designated by the SWRHL Operations Control Center.

All filters and charcoal cartridges were mailed directly to SWRHL for analysis. The filters were beta counted upon arrival at the laboratory and again on the fifth and twelfth day after collection. If the initial beta count indicated an activity concentration of more than one pCi/m^3, or if the five-day-count was more than 150 counts above background, the filter was gamma scanned. The charcoal cartridge was gross gamma counted upon arrival and if the count was greater than 500 counts per minute, the filter and cartridge were processed for gamma isotopic analysis.

The analytical results of the filters and cartridges collected for Gasbuggy were at background levels and were in agreement with ASN results during the periods of operation. Higher concentrations detected during the latter part of January, 1968, were a result of foreign atmospheric testing. A summary of air sampling results is presented in Table II of Appendix B.

No special air samples were collected by portable air samplers at any time during the test or the re-drill periods.

Milk Sampling

The basic milk sampling coverage was provided by the Gasbuggy Milk Surveillance Network, consisting of 22 stations. Thirteen of these stations were family milk cows and nine were Grade A dairies. These stations are listed in Table III, Appendix A and their locations are shown in Figure 3, Appendix A. Four of the Grade A dairies sampled are in the Standby Milk Surveillance Network maintained by SWRHL as part of the NTS off-site surveillance program.

Samples were collected at each location during the following periods: July 30 to August 1, 1967; September 4-7, 1967; October 20-25, 1967; and January 19-20, 1968. In addition, five samples were picked up on December 14, 1967. All samples were one-gallon samples and were shipped to SWRHL for analysis. The methods of analysis are covered below. A total of 75 samples was collected from this network; no other special samples were collected.

If venting had occurred, milk samples would have been collected from dairy and family cow locations within the actual effluent trajectory indicated by ground monitoring, air sampling, and other environmental surveillance results. The PHS Operations Control Center would have determined the actual sampling locations and the frequency and duration of collection. The locations of all milk cows were known from the pre-shot census. The time interval between sample collection and the availability of results would have been kept to a minimum in the event of a venting. Special sampling schedules could have been developed for aircraft pickup, where feasible, and analytical facilities could have been operated on a

24-hour basis, if necessary. To complement the milk sampling program, samples of all feed and water used by the milk cows would have been collected from locations where milk was collected.

The basic milk sampling coverage could have been supplemented by two additional networks:

a. Standby Milk Surveillance Network. This network of 153 stations in the eleven western states is maintained by SWRHL and can be requested to supply samples as needed for a given day or period of days.

b. Pasteurized Milk Network. This nationwide network of 44 stations provides weekly samples. Samples from the western states are analyzed at SWRHL. The remaining samples from the network are analyzed at the PHS's Northeastern and Southeastern Radiological Health Laboratories. The Network is operated by the Bureau of Radiological Health. Any station can be activated for a given period of days.

The analysis of the one-gallon milk samples consisted of two procedures, gamma counting and radiochemical analysis for strontium. Upon arrival of the sample at SWRHL, three and one-half liters of the sample were gamma scanned for 40 minutes. The gamma scan information was reviewed to determine the analysis procedure and was processed through a computer program which calculated values for iodine-131, cesium-137, barium-140, lanthanum-140, and total potassium based on potassium-40. If necessary, other combinations of isotopes could have been specified, but no sample required analysis beyond this routine procedure. The strontium analysis consisted of passing one liter of the sample through an

ion-exchange resin column which retained the strontium. The strontium was then precipitated as a carbonate compound and counted after weighing and again one week later. The strontium-89 and 90 activity concentrations are determined by solving simultaneous equations.

The results of all milk samples collected before and after the shot are summarized in Table III, Appendix B. Each sample was sent directly to SWRHL for analysis. The background samples collected during the October 20-25, 1967 period were not analyzed for ^{89}Sr or ^{90}Sr. The isotopic concentrations found after the shot were within the range of the levels found before the shot.

Water Sampling

The basic water sampling coverage was provided by a network of 34 sampling stations. Fifteen sampling locations were within 20 miles of ground zero at open and well water sources and 13 of the locations were the same as the family milk cow sampling stations. Six of the network locations were municipal water systems located approximately 120 miles from ground zero. These locations are given in Table IV, Appendix A and shown in Figure 4, Appendix A.

One-gallon samples were collected on the same schedule as the milk samples and sent to SWRHL for analysis. Upon arrival at SWRHL, three and one-half liters of the sample was gamma scanned for 40 minutes. This information was run through a computer program which routinely calculates values for the following isotopes:

cerium-praseodymium-144
iodine-131
ruthenium-106
cesium-137
zirconium-niobium-95
manganese-54
barium-lanthanum-140
potassium-40

If it had been determined that additional analysis for other radionuclides was necessary, a different set of isotopes could have been specified; however, no samples required this. After the gamma scan, 250 milliliters of the sample were evaporated and the residue counted for gross alpha and beta. If the activity was greater than 10 pCi/l at time of collection, a strontium analysis was performed. If the gross alpha was greater than 3 pCi/l, a radium-226 analysis was done.

The results of the 76 water samples collected before and the 25 collected after the shot are summarized in Table IV, Appendix B. None of the post-shot samples showed activity greater than background. Several of the sampling stations located within 20 miles of ground zero were not sampled post-shot as they were open water sources and were frozen.

Vegetation Sampling

Thirty-one natural vegetation samples were collected during the period of October 20-25, 1967, at all Gasbuggy Air Surveillance Network stations, except Grand Junction, Monticello, Denver, Rangely, and Carlsbad. The samples were collected to determine if there was any evidence of fresh fission products on vegetation in the area. Since no activity was found on these samples, no additional samples were taken before the event. All vegetation samples were collected and placed in sealed plastic bags and taken to the Farmington laboratory for analysis. Each bag was placed directly on a detector crystal and gamma scanned.

Post-shot vegetation samples were not collected since one to four feet of snow covered the ground in most areas.

If venting had occurred, samples of available vegetation would have been collected and gamma scanned to augment or substantiate other evidence of the cloud deposition pattern, especially width, and to serve as an indicator of where milk samples should be obtained.

Laboratory Facilities

A field laboratory was set up in Farmington under a contract between the BRH* and the State of New Mexico. The State of New Mexico supplied a laboratory and office space, a radiochemist, and a laboratory technician from June 1, 1967 to January 31, 1968.

The field laboratory was prepared to handle post-shot vegetation samples, air samples collected by monitors, samples collected by the SWRHL aircraft sampling systems, and selected milk and water samples on which immediate isotopic analyses would have been desired for guiding the sampling program.

All environmental samples were sent or taken either to SWRHL or the field laboratory in Farmington, depending on the type of sample. All milk, water, and network air samples were analyzed at SWRHL. All vegetation samples were analyzed in Farmington. The field laboratory was equipped with a TLD reader. The first set and approximately 85% of the second set of background exposed TLD's were read in Farmington. The remaining 15% of the second background set and all the post-shot exposed TLD's were read at SWRHL. The 15% portion was intended to insure correlation between the TLD readers in Las Vegas and Farmington.

*BRH-Bureau of Radiological Health

The radiochemist in the field laboratory performed all pre-shot radioassays for radon in the natural gas sampling program. The remaining pre-shot and all post-shot gas analysis was done at SWRHL.

X. NATURAL GAS

The PHS provided surveillance of radioactivity in the natural gas produced in the area surrounding the Gasbuggy site. This program consisted of an analysis for fresh fission products and natural radionuclides of the natural gas collected pre-shot and post-shot from all the wells and the gathering system located within five miles of ground zero. This gathering system was severed and capped prior to the shot so no gas from these wells could enter the El Paso Natural Gas System following the shot. This gathering system remains capped and out of production. Fifteen samples were analyzed before the detonation to determine background radioactivity levels and 31 samples were analyzed after the detonation to check for increased levels of radiation. In addition to the samples collected within five miles of ground zero, 12 samples were collected at more distant locations within the El Paso Natural Gas Company's system. All samples were analyzed for radioisotopes of xenon and krypton, and the nuclides of radon-222, carbon-14, and tritium. The analysis of the gas samples showed no evidence of fresh fission products in any sample. Background levels of radon-222 were found in all samples.

XI. EMERGENCY ACTION PROCEDURES

No pre-shot evacuation was scheduled; however, a program was set up to handle emergencies resulting from a venting of radioactive materials. The SWRHL personnel were prepared to handle possible pre-shot and post-shot evacuations. The actual plan for any pre-shot evacuation would have been drawn up by AEC Project Operations and implemented by the SWRHL field personnel as required by the AEC.

Emergency action procedures, for planning purposes, were divided into three phases. Phase I was pre-shot notification of officials in surrounding communities. Phase II was to be the implementation of emergency procedures. Phase III was to be the notification of any evacuees to return to their homes.

The pre-shot preparations included SWRHL contact of local officials and arrangements for suppliers of various goods and services. The personal contacts were made by the SWRHL Project Officer as part of the Community Relations Program. Various officials contacted in local communities including Mayors, Chiefs of Police, Health Officials, and other responsible officials, were told of possible hazards including type, degree, and location. Emphasis was made that any such emergency was extremely unlikely. All officials pledged their support to the extent necessary. Contacts were made with suppliers in the area including bus lines, motels, rental agencies, and laundries to ascertain the availability of equipment and supplies which might be needed.

All SWRHL personnel were briefed on procedures which might be followed if required during Phases II and III. No emergency action by the SWRHL was necessary, although additional personnel were available from the SWRHL had they been required.

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Appendix A - Table I. Sampling and Census Form

(PRINT ALL INFORMATION) ENVIRONMENTAL SURVEILLANCE PROGRAM

Code _____ Phone _____ Grade A B F G P

Power Supply: Pub. Utility____ Generator ____ Power Available PHS? Yes No

Lat. _____ Long. _____ Ranch _____ County _____

Nearest Town _____ State _____

Name of Resident (s) _____

Mailing Address _____ Length of Residence_____Yrs.

Locating Address_____

_____

POPULATION ADULTS (over 18)		DATE BIRTH Mo/Yr	MILK CONSUMED/DAY	TOTAL RESIDENTS Yr. Rd.	PART TIME Pt. Time	From	To
Male		x x x x					
Female		x x x x					
CHILDREN							
(No Names - Indicate sex by F or M)							

No. Milk Cows _____; Breed _____; _____G/D Milk Shipped _____Dairy

_____ Pickup Days: EOD, D, O . Time: AM PM

(City, State)

Type Ranch: Cattle, Sheep, Other Garden: Yes No

No. Acres_____ List Field Crops (Types & Acres) Alfalfa (____); Grass Hay (____)

Small Grain (____); Corn (____); Sorghum (____); Other (____)

FEED	HOW STORED PRO.	HOW STORED UNPR.	% OF DIET	TYPE FEED	DATES OF USAGE From	DATES OF USAGE To	LOC.	SPECIFY OTHER SOURCE (s)	DATES USED From	DATES USED To
Hay										
Pasture	x x	x x						x x x x x x	x x	x x
Green Chop								x x x x x x	x x	x x
Grain										
Silage								x x x x x x	x x	x x
Other										

WATER SUPPLY	WELL	MUNICIPAL	SURFACE OPEN	SURFACE COVERED	OTHER (Identify)
Domestic					
Crops					
Livestock					

Remarks: _____

_____

_____

Date _____ _____ Collected by _____

(ESO-1)

Appendix A

Table II Gasbuggy Air Surveillance Network

Station Code No.		Approximate azimuth from GZ	Approximate distance from GZ
	0-50 miles(10 stations)		
425	Pagosa Springs, Colorado*	15	42
426	Dulce, New Mexico*	35	22
427	Chama, New Mexico*	70	43
428	Tierra Amarilla, New Mexico*	90	38
429	Canjilon, New Mexico*	105	47
430	Coyote, New Mexico*	135	50
431	Cuba, New Mexico*	165	48
432	EPNG Lindreth Plant, New Mexico*	200	27
433	Allison, Colorado*	330	28
434	Gobernador, New Mexico*	280	9
	50-100 miles(12 stations)		
435	Del Norte, Colorado	35	84
436	Alamosa, Colorado	50	93
437	Romeo, Colorado	65	77
438	Tres Piedras, New Mexico	95	70
439	Taos, New Mexico	100	95
440	Ojo Caliente, New Mexico	115	72
442	Los Alamos, New Mexico	135	76
443	Santa Fe, New Mexico	135	100
444	Newcomb, New Mexico	255	89
445	Farmington, New Mexico*	275	55
446	Cortez, Colorado	300	89
086	Durango, Colorado**	320	55

Table II Gasbuggy Air Surveillance Network(continued)

Station Code No.		Approximate azimuth from GZ	Approximate distance from GZ
	100-180 miles(9 stations)		
447	Saguache, Colorado	35	114
508	Pueblo, Colorado #	50	182
449	Walsenburg, Colorado	65	180
450	Raton, New Mexico	85	157
451	Las Vegas, New Mexico	130	122
041	Albuquerque, New Mexico**	165	115
452	Grants, New Mexico	210	113
453	Gallup, New Mexico	230	118
088	Monticello, Utah**	310	125
	Additional ASN Stations		
076	Denver, Colorado**	30	246
505	Grand Junction, Colorado#	325	185
109	Rangely, Colorado**	330	250
042	Carlsbad, New Mexico**	150	390

* These stations remain in the field on standby. All other new stations were picked up in early May, 1968.

** Established ASN stations

Standby ASN Stations

GZ - ground zero

Appendix A

Table III Gasbuggy Milk Surveillance Network

Location Code No.	Town	Station
	Family Milk Cows 0-50 miles (8 stations)	
05-007-029	Pagosa Springs	Raymond Brown Ranch
30-039-319	Dulce	Erle Pettingill Ranch
30-039-144	Chama	Carl F. Black Ranch
30-039-173	Tierra Amarilla	Tony Manzanes Ranch
30-039-226	Coyote	Diego A. Chacon Ranch
30-039-211	Abiquiu	Monastery of Christ of the Desert
30-043-007	Regina	Ray Carr Ranch
05-067-229	Allison	Valley View Ranch
	Family Milk Cows 50-100 miles (5 stations)	
05-105-054	Del Norte	Henry Paulson Ranch
05-021-022	Romeo	Edwin Christensen Ranch
30-055-118	Tres Piedras	Mary Mayo Ranch
30-039-288	Ojo Caliente	Claude Lowery Ranch
30-043-073	Bernalillo	Mountain View Farm
	Grade A Dairies (9 stations)	
05-003-211	Alamosa	Alamosa Milk Company
05-071-212	Trinidad	Petramala Dairy
30-049-007	Nambe	Ranch de Los Lagunos
30-043-069	Bernalillo	Ridge Dairy
30-001-004	Albuquerque	McIlhaney's Dairy

Table III Gasbuggy Milk Surveillance Network (continued)

Location Code No.	Town	Station
	Grade A Dairies (9 stations) (continued)	
30-061-003	Los Lunas	Jones Dairy
30-061-004	Belen	Jareles Dairy
30-045-101	Farmington	Creamland Dairies
05-067-209	Durango	Clover Rich Dairy

Appendix A

Table IV Gasbuggy Water Surveillance Network

Location Code No.	Town	Station
	Stations 0-20 miles (15 stations)	
30-039-125	Carson National Forest	Fred M. Bixler Ranch
30-039-320	Dulce	Dulce Lake
30-039-311	E. Jicarilla Reservation	Well and Pond #1
30-039-312	E. Jicarilla Reservation	Pond #2
30-039-313	El Vado	El Vado Reservation
30-039-314	Central Jicarilla Reservation	Well and Pond #3
30-039-315	Carson National Forest	Laguna Seca
30-039-316	Carson National Forest	Aqua Bonita Spring
30-039-013	Gobernador	Arnold Ranch
30-039-035	EPNG Camp Largo	Water Supply
30-045-315	Archuleta	Navajo Reservoir
30-039-002	Gobernador-Blanco	John Pettus Ranch
30-039-340A	Gobernador	Gobernador School
30-039-317	Carson National Forest	Pond #4
30-039-318	Carson National Forest	Bubbling Spring
	Stations 20-50 miles - all were milk cow stations (8 stations)	
05-007-029	Pagosa Springs	Raymond Brown Ranch
30-039-319	Dulce	Dulce Water Supply
30-039-144	Chama	Carl F. Black Ranch
30-039-173	Tierra Amarilla	Tony Manzanes Ranch
30-039-226	Coyote	Diego A. Chacon Ranch
30-039-211	Abiquiu	Monastery of Christ of the Desert
30-043-007	Regina	Ray Carr Ranch

Table IV Gasbuggy Water Serveillance Network(continued)

Location Code No.	Town	Station
	Stations 20-50 miles - all were milk cow stations (8 stations)(continued)	
05-067-229	Allison	Valley View Ranch
	Stations 50-100 miles - all were milk cow stations (5 stations)	
05-105-054	Del Norte	Henry Paulson Ranch
05-021-022	Romeo	Edwin Christensen Ranch
30-055-118	Tres Piedras	Mary Mayo Ranch
30-039-288	Ojo Caliente	Claude Lowery Ranch
30-043-073	Bernalillo	Mountain View Farm
	City Water Supplies (6 stations)	
05-003-065	Alamosa	City Water Supply
30-055-123	Taos	City Water Supply
30-049-026	Santa Fe	City Water Supply
30-001-014	Albuquerque	City Water Supply
30-045-514	Farmington	City Water Supply
05-067-349	Durango	City Water Supply

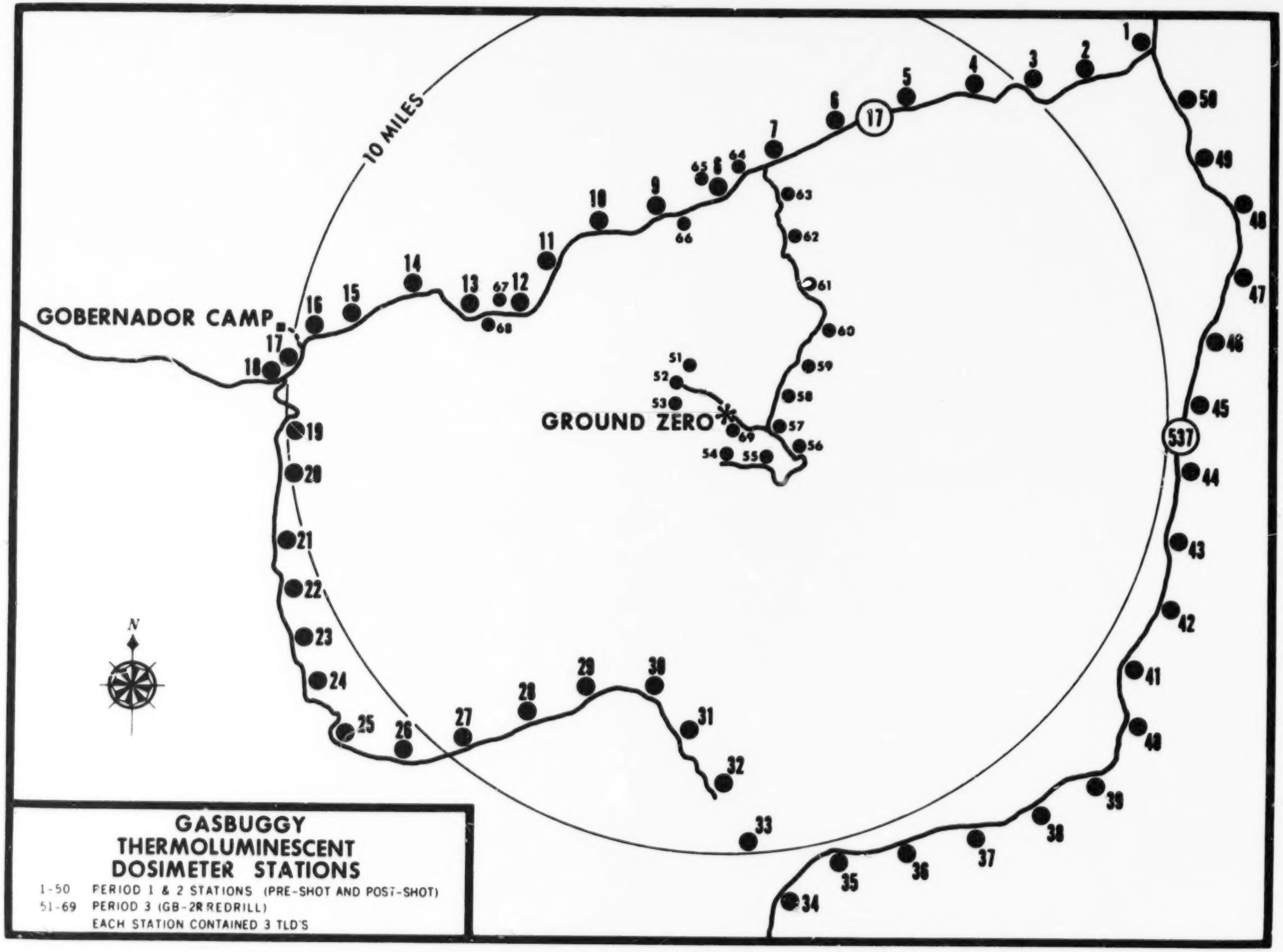

10 MILES
GOBERNADOR CAMP
GROUND ZERO
17
537
N
GASBUGGY
THERMOLUMINESCENT
DOSIMETER STATIONS
1-50 PERIOD 1 & 2 STATIONS (PRE-SHOT AND POST-SHOT)
51-69 PERIOD 3 (GB-2R REDRILL)
EACH STATION CONTAINED 3 TLD'S

Figure 1.

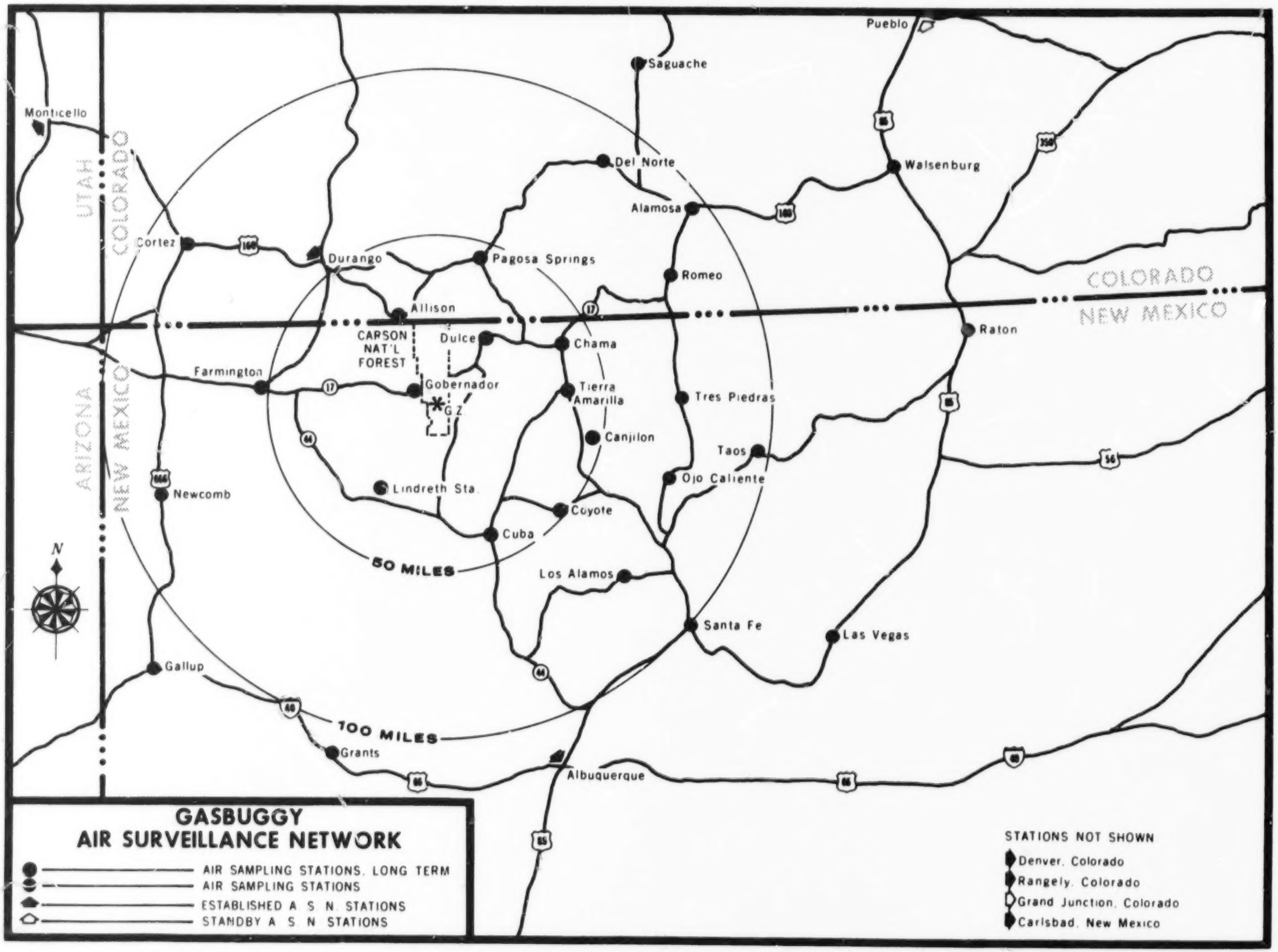

Pueblo
Saguache
Monticello
UTAH
COLORADO
Del Norte
Walsenburg
Alamosa
Cortez
Durango
Pagosa Springs
Romeo
COLORADO
NEW MEXICO
Allison
Raton
CARSON NAT'L FOREST
Dulce
Chama
Farmington
Gobernador
Tierra Amarilla
Tres Piedras
G Z
Canjilon
Taos
ARIZONA
NEW MEXICO
Ojo Caliente
Newcomb
Lindreth Sta.
Coyote
Cuba
50 MILES
Los Alamos
N
Santa Fe
Las Vegas
Gallup
100 MILES
Grants
Albuquerque
GASBUGGY
AIR SURVEILLANCE NETWORK
AIR SAMPLING STATIONS, LONG TERM
AIR SAMPLING STATIONS
ESTABLISHED A S N STATIONS
STANDBY A S N STATIONS
STATIONS NOT SHOWN
Denver, Colorado
Rangely, Colorado
Grand Junction, Colorado
Carlsbad, New Mexico

Figure 2.

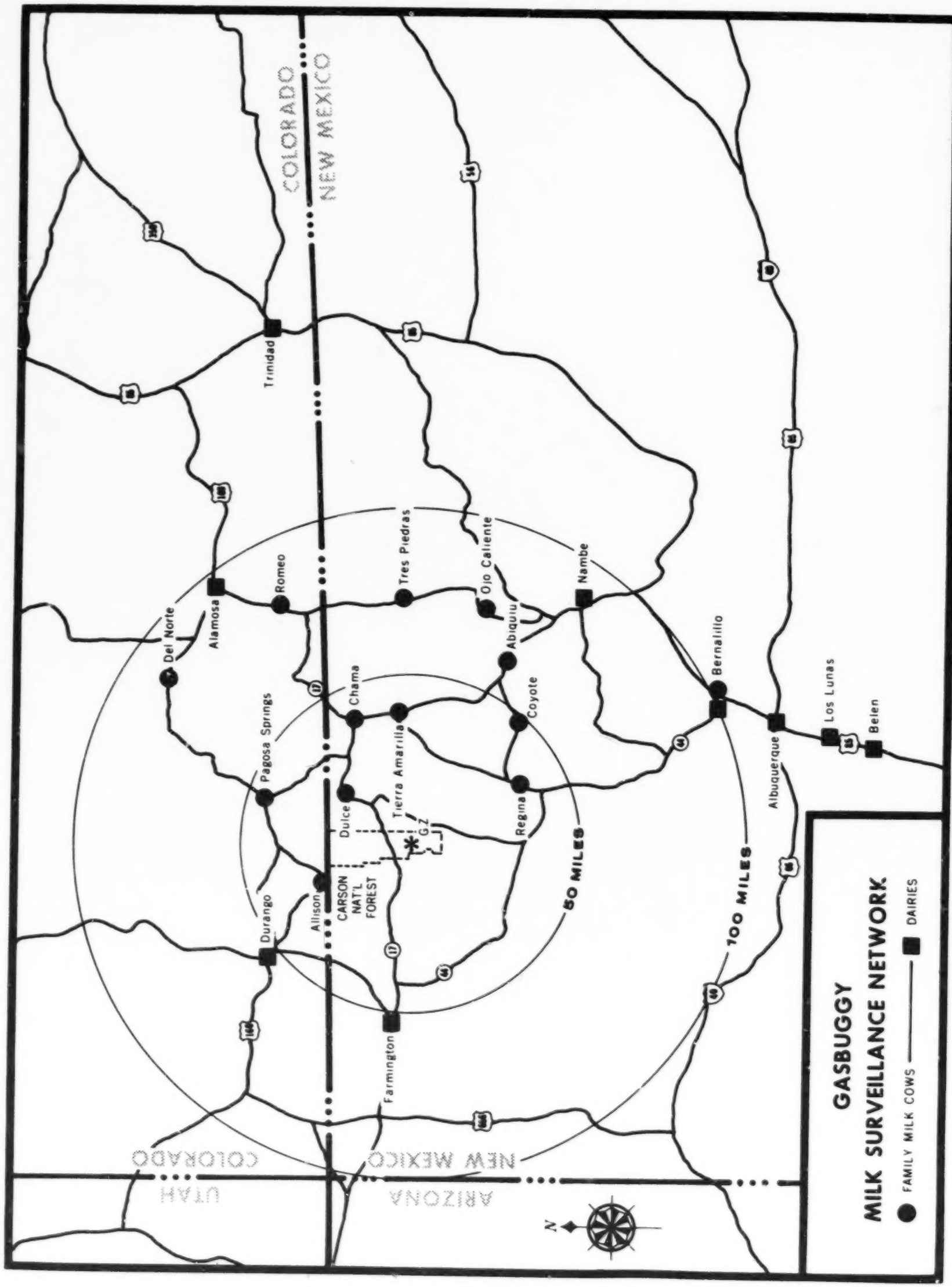

COLORADO
NEW MEXICO
Trinidad
Romeo
Tres Piedras
Ojo Caliente
Nambe
Del Norte
Alamosa
Abiquiu
Chama
Pagosa Springs
Coyote
Bernalillo
Los Lunas
Belen
Tierra Amarilla
Dulce
Regina
Albuquerque
Durango
Allison
CARSON NAT'L FOREST
G Z
50 MILES
100 MILES
Farmington
UTAH
COLORADO
NEW MEXICO
ARIZONA
N
GASBUGGY
MILK SURVEILLANCE NETWORK
FAMILY MILK COWS
DAIRIES

Figure 3.

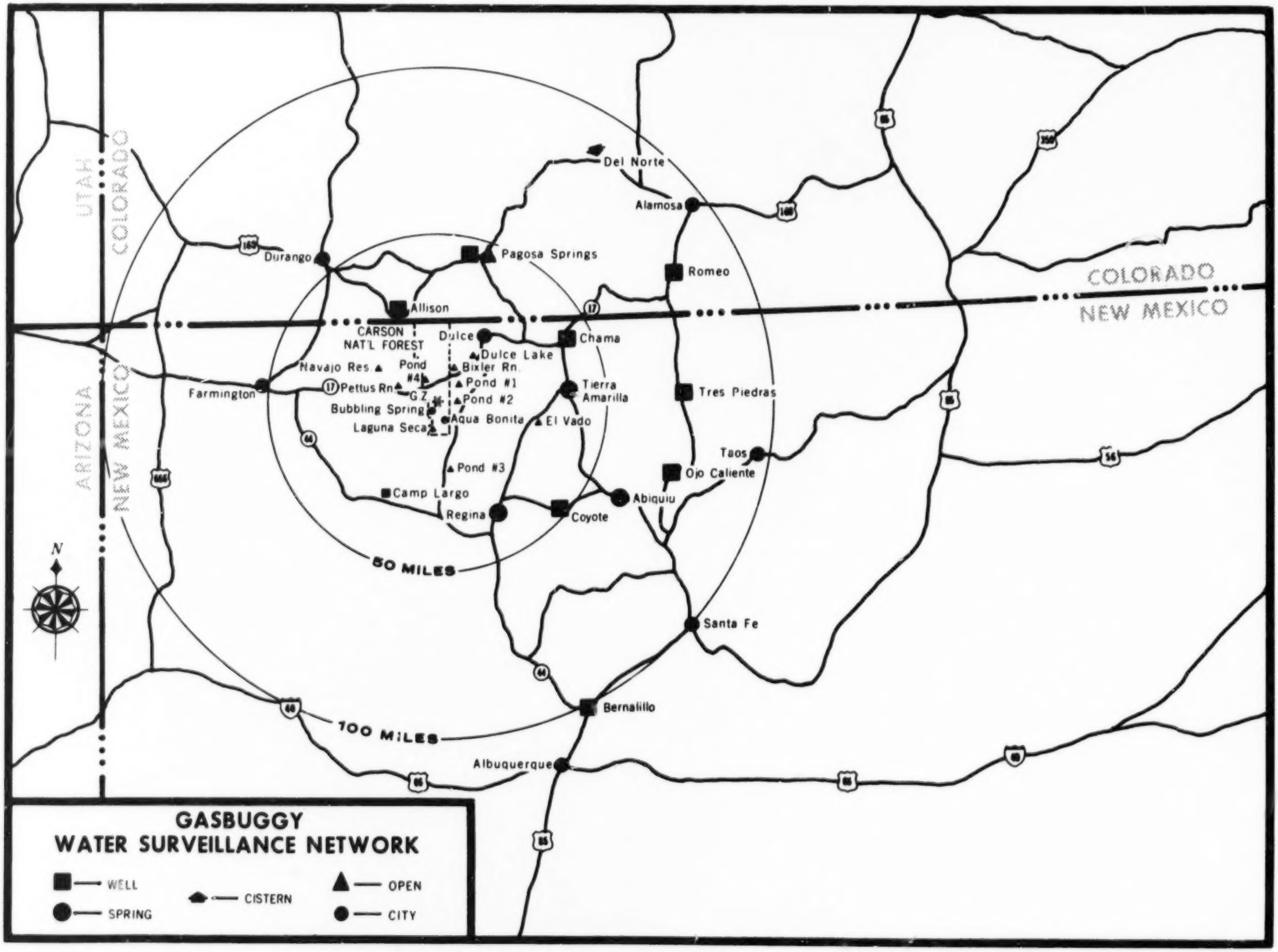
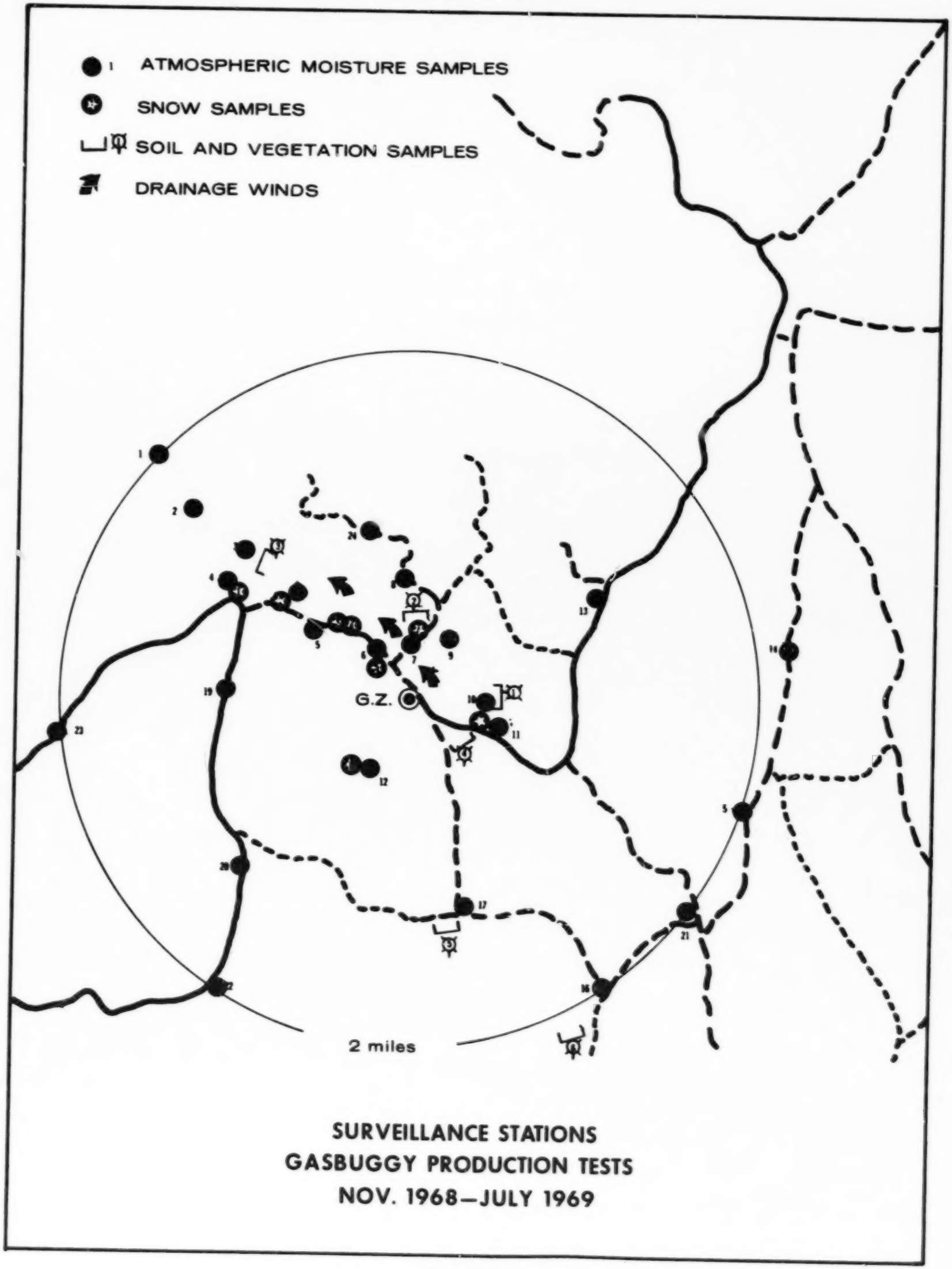

UTAH
COLORADO
ARIZONA
NEW MEXICO
COLORADO
NEW MEXICO
Del Norte
Alamosa
Durango
Pagosa Springs
Romeo
Allison
CARSON NAT'L FOREST
Dulce
Chama
Dulce Lake
Navajo Res.
Pond #4
Bixler Rn.
Pond #1
Farmington
Pettus Rn.
G.Z.
Pond #2
Tierra Amarilla
Tres Piedras
Bubbling Spring
Aqua Bonita
El Vado
Laguna Seca
Taos
Pond #3
Ojo Caliente
Camp Largo
Abiquiu
Regina
Coyote
50 MILES
Santa Fe
Bernalillo
100 MILES
Albuquerque
N
GASBUGGY
WATER SURVEILLANCE NETWORK
WELL
CISTERN
OPEN
SPRING
CITY

Figure 4.



SURVEILLANCE STATIONS
GASBUGGY PRODUCTION TESTS
NOV. 1968—JULY 1969

FIGURE 5

APPENDIX B

SUMMARY OF GASBUGGY SAMPLING RESULTS

Table I	Gasbuggy TLD Exposure Summary	41
Table II	Gasbuggy Air Surveillance Network Summary of Beta Activity	42
Table III	Gasbuggy Milk Analysis Results Summary	43
Table IV	Gasbuggy Water Analysis Results Summary	44

Appendix B - Table I - Gasbuggy TLD Exposure Summary

Period	Range of Station Averages (min)		(max)	Average of Station Averages
October 17, 1967 to November 15, 1967	0.23	to	0.64 mR/day	0.34 mR/day
November 15, 1967 to December 8, 1967	0.25	to	0.50 mR/day	0.37 mR/day
December 8, 1967 to January 15, 1968	0.29	to	0.50 mR/day	0.37 mR/day

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Appendix B - Table II - Gasbuggy Air Surveillance Network Summary of Beta Activities[1]

Period	Number of Stations Operating	Number of Samples Taken	Number of Samples Above Detectable Limits	Range (pCi/m^3) (min)	(max)	Average of Samples Above Detectable Limits (pCi/m^3)	Average of All Samples (pCi/m^3)
Pre-shot							
11/27/67 to 12/09/67	35	404	80	0.1	1.3	0.2	ND[2]
Post-shot							
12/10/67 to 12/24/67	35 or 12[3]	240	27	0.1	0.3	0.1	ND
12/25/67 to 1/19/68	12 or 25[4]	371	336	0.1	7.8	1.0	0.9
Selected ASN Stations[5]							
12/25/67 to 1/19/68	5	105	63	0.1	9.5	0.8	0.5

[1] Gamma scan results are not presented in summary form in this appendix. Gamma analysis results, none of which showed activities above background, are available from SWRHL.

[2] ND - Nondetectable. Detectable limit: Beta 0.1 pCi/m^3, based on 300 m^3 and 2 minute counting time.

[3] 12/10/67 to 12/13/67 35 stations operated. 12/13/67 to 12/24/67 12 stations operated.

[4] 1/12/67 to 1/11/68 12 stations operated. 1/11/68 to 1/19/68 25 stations operated.

[5] Selected ASN Stations:

Station	Station No.
Minneapolis	65
Berkeley	49
Seattle	50
Phoenix	43
New Orleans	92

These scattered stations were selected to show the increased activity was widespread.

Appendix B - Table III - Gasbuggy Milk Analysis Results Summary

Isotope	Number of Samples Analyzed	Number of Samples above Detectable Limit	Range (pCi/l) (min)	(max)	Average of samples above detectable limit (pCi/l)	Average of all samples (pCi/l)
Pre-shot						
^{131}I	52	0	--	--	--	ND
^{137}Cs	52	6	10	34	20	ND
^{89}Sr	30	4	5	5	5	ND
^{90}Sr	30	29	3	18	6	6
Post-shot						
^{131}I	23	0	--	--	--	ND
^{137}Cs	23	1	16	16	16	ND
^{89}Sr	20	2	5	5	5	ND
^{90}Sr	20	18	2	8	5	4

ND - Nondetectable

Detectable limits:

^{131}I 10 pCi/l - based on 3500 ml sample counted for 40 minutes.

^{137}Cs 10 pCi/l - based on 3500 ml sample counted for 40 minutes.

^{89}Sr 5 pCi/l - based on 1 liter sample counted for 50 minutes.

^{90}Sr 2 pCi/l - based on 1 liter sample counted for 50 minutes.

Appendix B - Table IV - Gasbuggy Water Analysis Results Summary*

Activity	Number of Samples Counted	Number of Samples above Detectable Limit	Range(pCi/l) (min)	(max)	Average of Samples above Detectable Limit(pCi/l)	Average of all Samples (pCi/l)
Pre-shot						
Beta	76	52	2	40	8	5
Alpha	76	25	1	23	4	1
Post-shot						
Beta	25	14	2	29	9	5
Alpha	25	7	1	16	3	1

*Results of gamma scans of all water samples were negative.

Detectable limits:

Beta - 2 pCi/l - based on 250 ml sample counted for 50 minutes
Alpha - 1 pCi/l - based on 250 ml sample counted for 50 minutes